

Advanced Design of Permanent Raised Bed Machinery in Pakistan

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Introduction

In the 1950s mechanical power use was introduced in agriculture of Pakistan in the shape of tube-wells, during the mid 1960s tractor and tillage equipment was launched. Currently, 593,334 tractors are available in the agricultural sector, and 23.8 million hectares of land is under cultivation, whereby one tractor cultivates an average 47.6 hectares. 310,524 tractors (46-55hp) are available to farmers which is 77% of the total. Out of 6.62 million farms, 19.5% are under 0.5 hectares, 16.5% between 0.5 to 1.0 hectares and 21.5% between 1.0 to 2.0 hectares. To fulfil the food requirement of the 173.38 million population of Pakistan the per capita availability of agricultural land is 0.14 hectare, and is going down day by day. Consumption of petroleum production in agriculture sector was 109,400 tonnes in 2008-09. The agriculture contribution to green house gas emission is 39% of which Carbon dioxide contributes 54%, Methane 36%, Nitrous oxides 9% and other gases 1%.

The machinery available on farm is given in Table 1. Keeping in view the above information Pakistan needs conservation agriculture through mechanization supported by Pakistan's available tractor horsepower (46-55 hp) and available farm size. Timely ploughing and seed bed preparation are not possible without tractors. Conservation agriculture means to minimize soil disturbance, maximise retention of previous crop residue and improve crop rotations with maximum profitability. A main attraction of conservation agriculture is cost -effectiveness with up to 15% savings on operational cost.

Tractor mounted Permanent Raised Bed (PRB) machinery was introduced in Pakistan in 1998 by an Australian government funded project. The PRB machinery shows very good results it has two parts namely a bed shaper and a no-till seeder. This machine is a good example of effective mechanization because it saves water, time and labour, improves grain yield and achieves a uniform distribution of seed and fertilizer. After 13 years of promotion, farmers are now familiar with raised bed technology, and are using different types of raised bed machinery while some farmers are using PRB machinery, especially in Khyber Pakhtunkhwa (KPK) and some part of Punjab. The PRB technology has proved its success but in Pakistan, our tractor horse power (46-55 hp) and the small farm size are obstacles to broad use of such machines suffering from high weight and cost. Therefore, we developed an advanced PRB machinery design which is low cost and light weight as well as versatile in its use.

Material and Methods

After the completion of a three year national project on permanent raised beds, a survey was conducted in all components of the project in Pakistan to evaluate the performance and working of PRB machinery. All farmers agreed that machinery is working very well and its results are very encouraging. They are getting more benefits as compared to traditional farming system. Particularly, 90% farmers related two key observations, namely i) two separate operations (bed making with bed shaper and sowing with no-till seeder) and ii) cost of the machinery (Rs. 320000/PRB machinery set). Pakistani farmers have very small land holdings with low economic affordability of the PRB machinery even with subsidies, petroleum prices are now very high and they cannot easily afford two operations for crop sowing on beds.

Following the survey, an advanced design of PRB machinery (ADPRB) was developed (Figure 1) and this multipurpose machinery responding to the farmer requirements is now tested and approved

for distribution. The ADPRB have all abilities of PRB machinery combined in a single operation, it can achieve an adjustable bed size from 90cm (single bed) to 25cm (double bed), plant six rows of wheat and rice and two rows of maize and cotton on a 90cm bed and two rows of wheat and rice and one row of maize and cotton on a 25cm bed. The machinery is capable for maintaining the row to row distance and also plant to plant distance according to the crop requirement (see Figure 2, Figure 3, and Figure 4).

The ADPRB machine comprises four parts, namely i) the front bar with three furrow openers, two blades and one shaft with four cutters (NB: the cutters are used for hoeing on beds between rows of cotton and maize), ii) fertilizer and seed boxes, a shaft with five cutters and one roller, iii) six tines with double disk furrow openers for wheat and rice seed and iv) a precision seed metering system for maize and cotton to maintain plant to plant distance. The blades and cutters are used for renovation and reshaping of beds. The bed renovation & reshaping, sowing of crop and distribution of fertilizer are all performed in a single pass using the ADPRB machine. The cost of this machine was calculated as Rs. 120000, which is affordable for all types of farmers in Pakistan. A study was also conducted on wheat crop sowing with this machine at Gujjar farm, Haripur, KPK. Wheat was sown on raised beds with six rows at the end of December 25th 2010 to assess the ADPRB machine performance and operation.

Results and Discussion

The results show that farmers are now interested in purchasing the ADPRB machine because of its low cost and within the 15 days of display of ADPRB machine 20 farmers placed orders to purchase the ADPRB machine (i.e. 10 from in KPK, 5 from in Balochistan, and 5 from in Sindh) but due to financial constraints, the project is unable to meet the orders. The results revealed that six rows of wheat on 90cm bed germinated very well as shown in Figure 2. Fuel consumption for sowing was also less as compared with previous PRB machinery, the results also show that grain yield was 2,370 kg/ha as compared with flat sowing on basin irrigation system which was 1,580 kg/ha, a 33% yield increase. The grain yield was very low due to late sowing at the last week of the December 2010; even then the crop on raised beds was better than drill sowing on flat field. Results shows that due to its light weight of the three point linkage mounted ADPRB machine, a 55hp tractor easily operates the machine and the tractor driver is satisfied with its performance. We are now working on some more improvements to the ADPRB machine to make it more efficient. A comparison of the PRB and ADPRB machines is given in Table 2.

References

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Figures and Tables

Table 1: Levelling and cultivating implements owned by tractor owners
(NB: 593,334 tractors are available in the agricultural sector)

	Blade	Culti- vator	Mould- board Plough	Disk Plough	Chisel Plough	Ripper/ subsoiler	Rotovator	Disk harrow	Ridger	Laser leveller
Total	233,126	369,866	40,050	29,218	8,514	1,655	47,919	23,764	71,338	2,785
Govern- ment	893	563	224	179	97	7	173	155	107	181
Private	232,233	369,303	39,826	29,039	8,417	1,648	47,746	23,609	71,231	2,604



Figure 1: View of ADPRB machinery



Figure 2: Six wheat seed rows established on PRB



Figure 3: Maturing wheat crop on six row PRB



Figure 4: Field test of cotton seed dropping

Table 2. Comparison of PRB and ADPRB machine specifications

Inputs	PRB	ADPRB
Bed Making	Yes	Yes
Sowing	Yes	Yes
Renovation	Yes	Yes
Furrow Depth	Adjustable	Adjustable
Seed rate	Adjustable	Adjustable
Number of operations for Renovation and sowing	2	1
Row to row distance	Yes	Yes
Plant to plant distance in cotton and maize	No	Yes
Hoeing in cotton and maize	No	Yes
Weight	350 & 450 kg	225 kg
Cost	Rs. 320000/-	Rs. 120000/-